Remarks

In the Office Action, Applicants' recited invention of claims 1-4, 10-12, 18-20, 23-25 & 29 was rejected under U.S.C. §102(e) as being anticipated by Wheeler et al. (U.S. Patent No. 5,825,680), while claims 5-6, 9 & 21 were rejected under U.S.C. §103(a) as being unpatentable over Wheeler et al. further in view of Hang et al. (U.S. Patent No. 5,710,595), claims 7-8, & 22 were rejected under U.S.C. §103(a) as being unpatentable over Wheeler et al. further in view of Riek et al. (U.S. Patent No. 5,987,179), and claims 13-17 & 26-28 were rejected under 35 U.S.C. §103(a), as being unpatentable over Wheeler et al. further view of Hosono (U.S. Patent No. 5,796,438). Each of these rejections is respectfully, but most strenuously, traversed for the reasons stated below.

The present invention recites a method, system and computer program product (claims 1, 18 & 29) that allow for the encoding of a sequence of video data. The encode approach includes storing within a quantizer multiple sets of quantization matrix tables at the same time (e.g., 263, 264 of FIG. 6). The sets of quantization matrix tables are separate and independent (e.g., 270, 280 of FIG. 7), and each set comprises at least one intra-matrix table and at least one non intra-matrix table (see FIG. 7). As used herein, a "table" comprises multiple coefficients or entries, e.g., an 8·8 array of coefficients. A "set" of tables comprises two or more tables. Each set is recited to comprise at least one intra-matrix table and at least one non intra-matrix table. A quantizer (e.g., 250 of FIG. 6) quantizes the sequence of video data in a single pass using one set of the multiple sets of quantization matrix tables. Means (e.g., 261 of FIG. 6) are also provided for dynamically switching the quantizer from using the one set of quantization matrix tables to using another set of quantization matrix tables. See page 14, line 28 – page 17, line 7 of the specification. As recited in the claims presented, this dynamically switching occurs in real-time and occurs without requiring stopping of the encode process. Further, while one set of quantization matrix tables within the quantizer is being employed, another set of quantization matrix tables can be updated or modified within the quantizer.

Additionally, and responsive to the latest Office Action, applicants wish to emphasize that the pending claims (a copy of which is attached as an Appendix) recite storing within a

quantizer multiple "sets of quantization matrix tables" at the same time. Each "quantization matrix table" is defined to include at least one intra-matrix table and at least one non-intra-matrix table. In the conventional single set of matrix tables implementation, the set of matrix tables comprises two or four tables, with each table containing 64 values. In a 4:2:0 mode, two tables are used, one for intra blocks and the other for non-intra blocks. In 4:2:2 mode, four tables are used, one for intra-illuminance blocks, one for non-intra illuminance blocks, one for intra-chrominance blocks, and the last for non-intra chrominance blocks. See page 13, lines 20-27 of the specification.

Thus, the phrase "quantization matrix tables" is a well understood term of art, which is distinguished from and different structures than the QUANT value (also known as the MQUANT value or Q-Stepsize). The QUANT value is also used in MPEG encoding to reduce the amount of data in a picture. The QUANT value is a global number or scale factor that applies to all macroblocks in a picture. For example, conventionally the macroblock data is divided by the QUANT value in order to compress the data. The QUANT value is typically only one value per picture and, again, it is distinct from the "quantization matrix tables" which are used as recited in the present claims and described in applicants' specification. A QUANT value does not equal nor is it analogous to a quantization matrix table. The two refer to different structures which are used in the encoding process. Applicants' claims are specific to storing within a quantizer multiple sets of "quantization matrix tables" at the same time.

With respect to applicants' independent claims, Wheeler et al. describe a method and apparatus for performing fast division in accordance with certain bandwidth requirements particular to an implementation described therein. A pseudo pipelined approach for performing division using the SRT non-restoring division algorithm is described which uses a minor clock and a major clock cycle time. The number of stages in the division pipeline is a function of the parameters bandwidth requirements of the system. More particular to the present invention, the Office Action cites column 13, lines 18-32 of Wheeler et al. as relevant to the presently claimed invention. These lines describe a quantization unit 644 shown in FIG. 28. In the preferred embodiment, there are two quantization tables; i.e., one table is used when operating on intra-coded macroblocks, and the other table is used on non-intra-

coded macroblocks. These quantization tables are stored in queue table RAMS 690. At column 13, lines 24-32, the patent states:

> ...In the preferred embodiment there are two quantization tables; one table is used when operating on intra-coded macroblocks, the other table is used on non-intra-coded macroblocks.
>
> As shown in FIG. 7, the quantization tables are stored in Q table RAMS 690. The CPU is responsible for loading all Q table entries. During encode and decode, the CPU loads the tables as required. Thus, the CPU is responsible for updating Q tables on video stream context switches.

Applicants respectfully submit that a careful reading of Wheeler et al. indicates that the patent is describing the MPEG standard which requires the use of an intra-coded matrix table and a non-intra-coded matrix table, and therefore requires a switching from the intra table to the non-intra table during the encoding process. The above-noted lines of column 13 of the patent would be read by one skilled in the art as referring to this switching between intra and non-intra tables at a context switch, e.g., a scene change.

Applicants invention recited in claim 29 (for example) includes computer readable program code means for storing multiple sets of quantization matrix tables within a quantizer at the same time, wherein each set of quantization matrix tables comprises a separate, independent set of tables, and each set comprises at least one intra matrix table and at least one non-intra matrix table. The present invention assumes a normal "real time" switching of intra and non-intra tables such as described in Wheeler et al., but further adds the ability to dynamically switch in real-time from one complete set of intra and non-intra tables to another complete set of intra and non-intra tables in a single pass without requiring stopping of the encoding process. Further, applicants' recited invention allows the updating of one set of quantization matrix tables within the quantizer while another set of quantization matrix tables is in use. Again, each set comprises at least one intra matrix table and at least one non-intra matrix table.

In applicants' claimed invention, an enhancement is submitted whereby a user is allowed multiple sets of quantization matrix tables within the quantizer, with each set comprising at least one intra matrix table and at least one non-intra matrix table. By holding multiple sets of quantization matrix tables within the quantizer at the same time, and

maintaining these tables separate and independent, applicants are able to allow for dynamic switching in real-time of complete sets of quantization matrix tables without requiring stopping of an encode process. Further, applicants allow for the dynamic updating of a set of quantization matrix tables within the quantizer while another set of quantization matrix tables is in use by the quantizer.

A careful reading of Wheeler et al. fails to uncover any discussion of switching between complete sets of tables. The patent expressly teaches in a preferred embodiment there are two quantization tables. One table is for operating on intra-coded macroblocks, and the other table is used for non-intra-coded macroblocks. In contrast, applicants recite switching between full sets of tables, wherein one set comprises at least one intra matrix table and at least one non-intra matrix table. Thus, in applicants' approach, there are a minimum of four quantization tables within the quantizer at the same time between which the dynamic switching occurs.

Further, applicants' independent claims recite allowing updating of one set of quantization matrix tables of the multiple sets of quantization matrix tables within the quantizer while another set of quantization matrix tables is in use by the quantizer. For an alleged teaching this concept, the Office Action references column 9, lines 25-36 of Wheeler et al. Applicants' respectfully submit that this reference mischaracterizes the teachings of Wheeler et al. The cited lines of Wheeler et al. address the MQUANT value, and the providing of a range of MQUANT values so that a user can select an appropriate MQUANT value to control the allocation of bits. As noted above, applicants independent claims define a single set of "quantization matrix tables" to comprise at least one intra-matrix table and at least one non-intra-matrix table. Based on this definition, the table of MQUANT values described by Wheeler et al. is distinct from applicants' recited "sets of quantization matrix tables". Again, the MPEG standard defines both "quantization matrix tables" and "MQUANT value" as separate concepts within the encoding process. For these reasons, the Office Action's characterization of the discussion in Wheeler et al. at column 9, lines 24-36 as relevant to applicants recited invention is respectfully traversed and reconsideration thereof is requested.

For all the above reasons, applicants respectfully submit that the independent claims presented herewith patentably distinguish over the teachings of Wheeler et al. The dependent claims are believed allowable for the same reasons as the independent claims, as well as their own additional characterizations.

With respect to the obviousness as rejection of claims 5, 6, 9 & 21, based on Wheeler et al. in view of Hang et al., applicants initially note that Hang et al. does not teach, suggest or imply any of the above-noted deficiencies of Wheeler et al. when applied against their independent claims. Hang et al. is cited in the Office Action for allegedly teaching a "default quantization matrix table". This characterization of Hang et al. is respectfully traversed.

As noted above, the encoding art and the MPEG encoding standard in particular, define the meaning of a "quantization matrix table". Further , a "quantization matrix table" is clearly distinct from an MQUANT value (QUANT value, Q-step) or a table of such values. The quantization matrix table contains certain information such as recited by applicants in the independent claims presented, which is distinct that from that of the MQUANT value. Hang et al. described retrieving a default Q-step value from a table of default quantization step size values (see abstract). Thus, Hang et al. do not describe applicants recited concept in claim 5, for example, of providing a "default quantization matrix table". Again, applicants independent claims recite storage within a quantizer for holding multiple "sets of quantization matrix tables" at the same time, wherein each set of quantization matrix tables includes at least one "intra-matrix table" and at least one "non-intra-matrix table". Since the table of Q-step values in Hang et al. is employed in a different portion of the quantization process, applicants respectfully submit that there is no teaching in Hang et al. of applicants further characterizations as set forth in the dependent claims at issue, and thus, that there is no suggestion in the combination of Hang et al. and Wheeler et al. for applicants' invention as recited in dependent claims 5, 6, 9 & 21. Reconsideration of the rejection is therefore respectfully requested.

The remaining obviousness as rejections to dependent claims 7, 8 & 22 (based on Wheeler et al. in view of Reik et al.) and claims 13-17, 26-28 (based on Wheeler et al. in view of Hosono) are also respectfully traversed. Neither Reik et al. or Hosono et al. address

any of the above-noted deficiencies of Wheeler et al. when applied against applicants' recited independent claims. Reik et al. is cited in the Office Action as disclosing utilizing custom quantization matrix tables, while Hosono is cited in the Office Action for outputting a "Q-matrix extension start code" in a compressed bit stream. Without acquiescing to the characterizations of the teachings of these patents, applicants' note that neither patent is cited for the basic deficiencies of Wheeler et al. when applied against the independent claims. For these reasons, these dependent claims are also believed to be in condition for allowance.

Based upon the above, applicants' respectfully request reconsideration and allowance of all pending claims.

If a telephone conference would be of assistance in advancing prosecution of this application, Applicants' undersigned attorney invites the Examiner to telephone him at the number provided.

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Appendix

1. (Previously Presented) An encoder for encoding a sequence of video data, said encoder comprising:

storage within a quantizer for holding multiple sets of quantization matrix tables at the same time, wherein said multiple sets of quantization matrix tables comprise separate, independent sets of quantization matrix tables, each set of quantization matrix tables comprising at least one intra matrix table and at least one non-intra matrix table;

said quantizer for quantizing said sequence of video data in a single pass using at least one set of quantization matrix tables of said multiple sets of quantization matrix tables; and

means for dynamically switching in real time said quantizer during said single pass quantizing from using said one set of quantization matrix tables to using another set of quantization matrix tables of said multiple sets of quantization matrix tables, wherein said dynamically switching occurs without requiring stopping of the encoding process; and

means for allowing updating of said one set of quantization matrix tables of said multiple sets of quantization matrix tables within said quantizer while said another set of quantization matrix tables is in use by said quantizer.

2. (Original) The encoder of claim 1, wherein said means for dynamically switching comprises means for switching said quantizer from using said one set of quantizer matrix tables to using said another set of quantizer matrix tables at a picture boundary of said sequence of video data.

3. (Original) The encoder of claim 2, wherein said means for switching said quantizer at said picture boundary comprises means for switching from said one set of

quantizer matrix tables to said another set of quantizer matrix tables without delaying encoding of said sequence of video data by said encoder.

4. (Original) The encoder of claim 3, wherein said means for dynamically switching further comprises a table set register within said quantizer adapted to control said switching of said quantizer from said one set of quantization matrix tables to said another set of quantization matrix tables.

5. (Original) The encoder of claim 1, wherein at least one table of said one set of quantization matrix tables comprises a default quantization matrix table pursuant to MPEG standard.

6. (Original) The encoder of claim 1, wherein multiple tables of said one set of quantization matrix tables comprise default quantization matrix tables pursuant to MPEG standard.

7. (Original) The encoder of claim 1, wherein at least one table of said another set of quantization matrix tables comprises a user's custom quantization matrix table.

8. (Original) The encoder of claim 1, wherein multiple tables of said another set of quantization matrix tables comprises a user's custom quantization matrix tables.

9. (Original) The encoder of claim 1, wherein each set of quantization matrix tables of said multiple sets of quantization matrix tables comprises at least one quantization matrix table, each quantization matrix table of said at least one quantization matrix table comprising one of a default quantization matrix table pursuant to MPEG standard or a user's custom quantization matrix table.

10. (Original) The encoder of claim 1, wherein each set of quantization matrix tables comprises an intra luminance table and a non-intra luminance table.

11. (Original) The encoder of claim 1, wherein each set of said multiple sets of quantization matrix tables comprises an intra luminance table, a non-intra luminance table, an intra chrominance table, and a non-intra chrominance table.

12. (Original) The encoder of claim 1, further comprising means for dynamically changing quantization matrix tables of a presently unused set of quantization matrix tables of said multiple sets of quantization matrix tables while quantizing said sequence of video data using said one set of quantization matrix tables or said another set of quantization matrix tables.

13. (Original) The encoder of claim 1, further comprising a compressed store interface for outputting a compressed bitstream produced by said encoder from said sequence of video data, said compressed store interface including means for dynamically outputting a quantization matrix extension start code in said compressed bitstream upon switching of said quantizer from using said one set of quantization matrix tables to using said another set of quantization matrix tables.

14. (Original) The encoder of claim 13, wherein said compressed store interface further comprises storage for also holding said multiple sets of quantization matrix tables.

15. (Original) The encoder of claim 13, wherein said means for dynamically outputting said quantization matrix extension start code comprises means for outputting said another set of quantization matrix tables in said compressed bitstream upon said quantizer switching from said one set of quantization matrix tables to said another set of quantization matrix tables.

16. (Original) The encoder of claim 13, wherein said means for dynamically outputting comprises means for outputting said quantization matrix extension start code in said compressed bitstream without pausing said encoding of said sequence of video data by said encoder.

17. (Original) The encoder of claim 13, further comprising means for changing quantization matrix tables in a presently unused set of said multiple sets of quantization matrix tables while said quantizer is quantizing said sequence of video data using said one set of quantization matrix tables or said another set of quantization matrix tables.

18. (Previously Presented) A method for encoding a sequence of video data, said method comprising:

providing storage within a quantizer of an encoder for holding multiple sets of quantization matrix tables at the same time, wherein said multiple sets of quantization matrix tables comprise separate, independent sets of quantization matrix tables, each set of quantization matrix tables comprising at least one intra matrix table and at least one non-intra matrix table;

quantizing the sequence of video data in a single pass using at least one set of quantization matrix tables of said multiple sets of quantization matrix tables; and

dynamically switching in real time said quantizing during said single pass from using said one set of quantization matrix tables to using another set of quantization matrix tables of said multiple sets of quantization matrix tables, wherein said dynamically switching occurs without requiring stopping of the encoding process; and

allowing updating of said one set of quantization matrix tables of said multiple sets of quantization matrix tables within said quantizer while said another set of quantization matrix tables is in use by said quantizer.

19. (Original) The method of claim 18, wherein said dynamically switching comprises switching said quantizing from using said one set of quantizer matrix tables to using said another set of quantizer matrix tables at a picture boundary of said sequence of video data.

20. (Original) The method of claim 19, wherein said switching of said quantizing at said picture boundary comprises switching from said one set of quantizer matrix tables to said another set of quantizer matrix tables without delaying encoding of said sequence of video data.

21. (Original) The method of claim 18, wherein at least one table of said one set of quantization matrix tables comprises a default quantization matrix table pursuant to MPEG standard or a user's custom quantization matrix table.

22. (Original) The method of claim 18, wherein at least one table of said another set of quantization matrix tables comprises a default quantization matrix table pursuant to MPEG standard or a user's custom quantization matrix table.

23. (Original) The method of claim 18, wherein each set of said multiple sets of quantization matrix tables comprises an intra luminance table and a non-intra luminance table.

24. (Original) The method of claim 18, wherein each set of said multiple sets of quantization matrix tables comprises an intra luminance table, a non-intra luminance table, an intra chrominance table, and a non-intra chrominance table.

25. (Original) The method of claim 18, further comprising dynamically changing quantization matrix tables of a presently unused set of quantization matrix tables of said multiple sets of quantization matrix tables while quantizing said sequence of video data using said one set of quantization matrix tables or said another set of quantization matrix tables.

26. (Original) The method of claim 18, further comprising producing a compressed bitstream employing a compressed store interface, said producing comprising dynamically outputting a quantization matrix extension start code in said compressed bitstream upon said switching from said one set of quantization matrix tables to said another set of quantization matrix tables.

27. (Original) The method of claim 26, wherein said dynamically outputting comprises outputting said quantization matrix extension start code in said compressed bitstream without pausing said encoding of said sequence of video data.

28. (Original) The method of claim 26, further comprising changing quantization matrix tables in a presently unused set of said multiple sets of quantization matrix tables while quantizing said sequence of video data using said one set of quantization matrix tables or said another set of quantization matrix tables.

29. (Previously Presented) An article of manufacture comprising:

a computer program product comprising computer usable medium having computer readable program code means therein for use in encoding a sequence of video data, said computer readable program code means in said computer program product comprising:

computer readable program code means for causing a computer to effect storing within a quantizer multiple sets of quantization matrix tables at the same time, wherein said multiple sets of quantization matrix tables comprise separate, independent sets of quantization matrix tables, each set of quantization matrix tables comprising at least one intra matrix table and at least one non-intra matrix table;

computer readable program code means for causing a computer to effect quantizing the sequence of video data in a single pass using at least one set of quantization matrix tables of said multiple sets of quantization matrix tables; and

computer readable program code means for causing a computer to effect dynamically switching in real time said quantizing during said single pass from using said one set of quantization matrix tables to using another set of quantization matrix tables of said multiple sets of quantization matrix tables, wherein said dynamically switching occurs without requiring stopping of the encoding process; and

computer readable program code means for causing a computer to effect allowing updating of said one set of quantization matrix tables of said multiple sets of quantization matrix tables within said quantizer while said another set of quantization matrix tables is in use by said quantizer.

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